Texas Disasters II

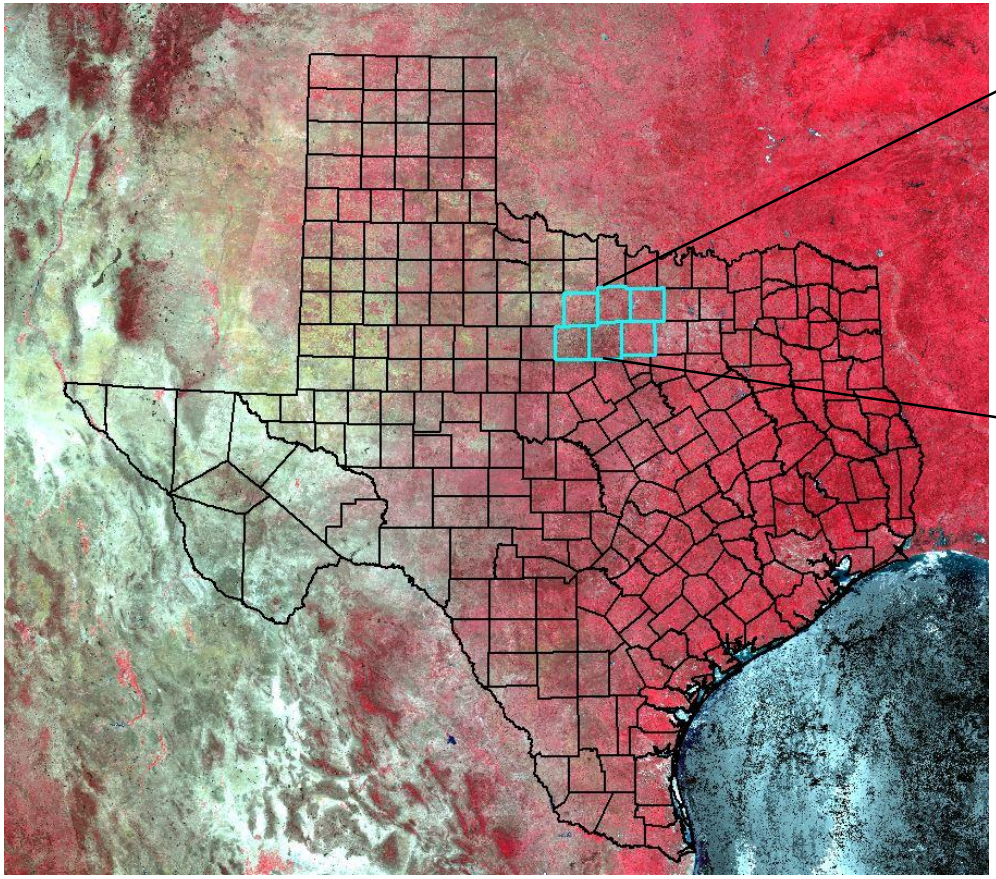
Utilizing NASA Earth Observations to Assist the Texas Forest Service in Mapping and Analyzing Fuel Loads and Phenology in Texas Grasslands

Michael Brooke (Project Lead)
Meredith Williams
Teresa Fenn

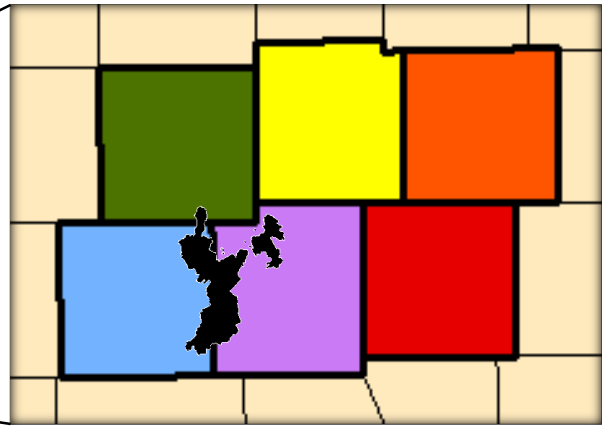
Objective

Assist the Texas Forest Service in **Mapping** and **Analyzing** Fuel Loads and Phenology in Texas Grasslands

Study Area



Background image: MODIS false color composite 6/17/14



Young County
Jack County
Wise County
Stevens County
Palo Pinto County
Parker County

Study Period

January 2000-November 2015

Partners

Texas Forest Service

Image Credit: Texas Forest Service

USDA Forest Service

Image Credit: USDA Forest Service

Community Concerns

Environment

Texas vegetation are **highly susceptible** to wildfires.

The risk of severe wildfires related to **weather phenomena**

Wildfire risk has increased due to climate change and recent development.

The **combination** of **El Nino** and **La Nina** events, which can lead to more intense fire seasons.

The **Texas Forest Service** is tasked with **evaluating** and **reducing** potential fire risk.

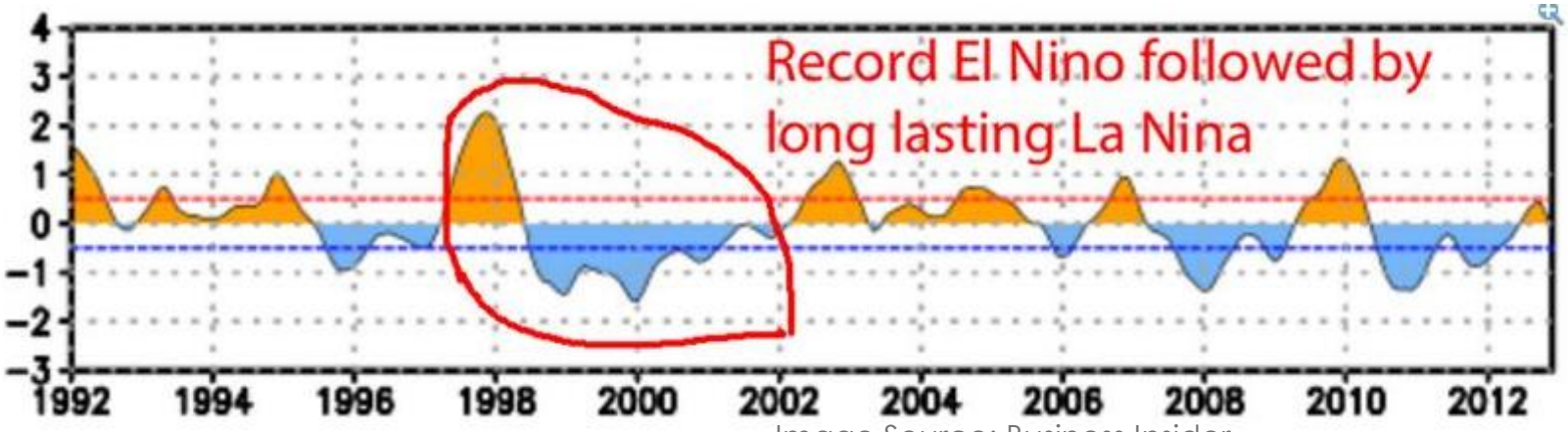
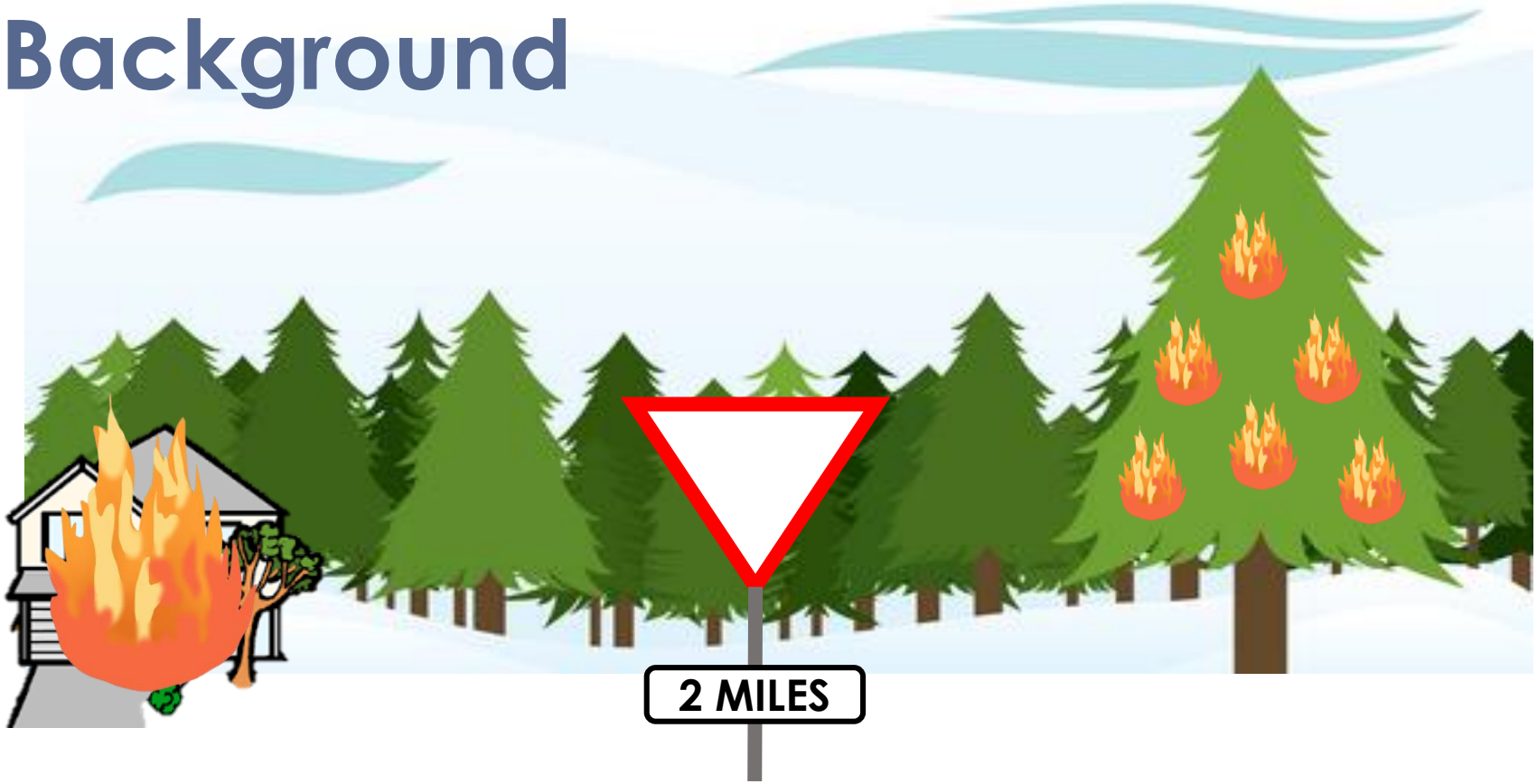


Image Source: Business Insider

Background

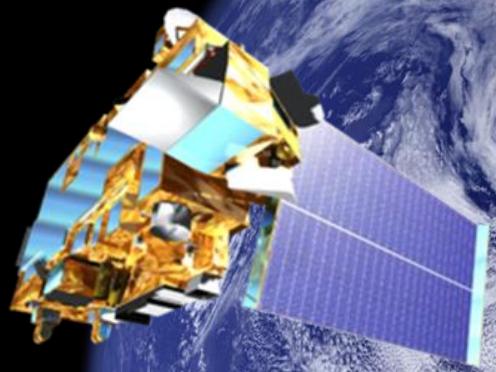
Increased Fuel Loads

Background

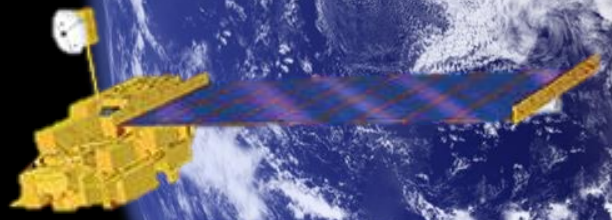


- In 2011, 31,453 wildfires burned 4 million acres & destroyed 2,947 homes
- 80% of wildfires occur within 2 miles development areas
- Six of the 10 largest documented wildfires in state history occurred in April 2011

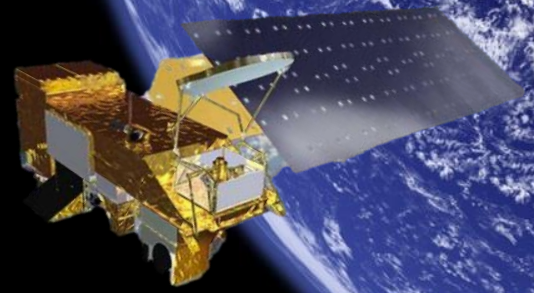
NASA Satellites/Sensors



AQUA MODIS



TERRA MODIS



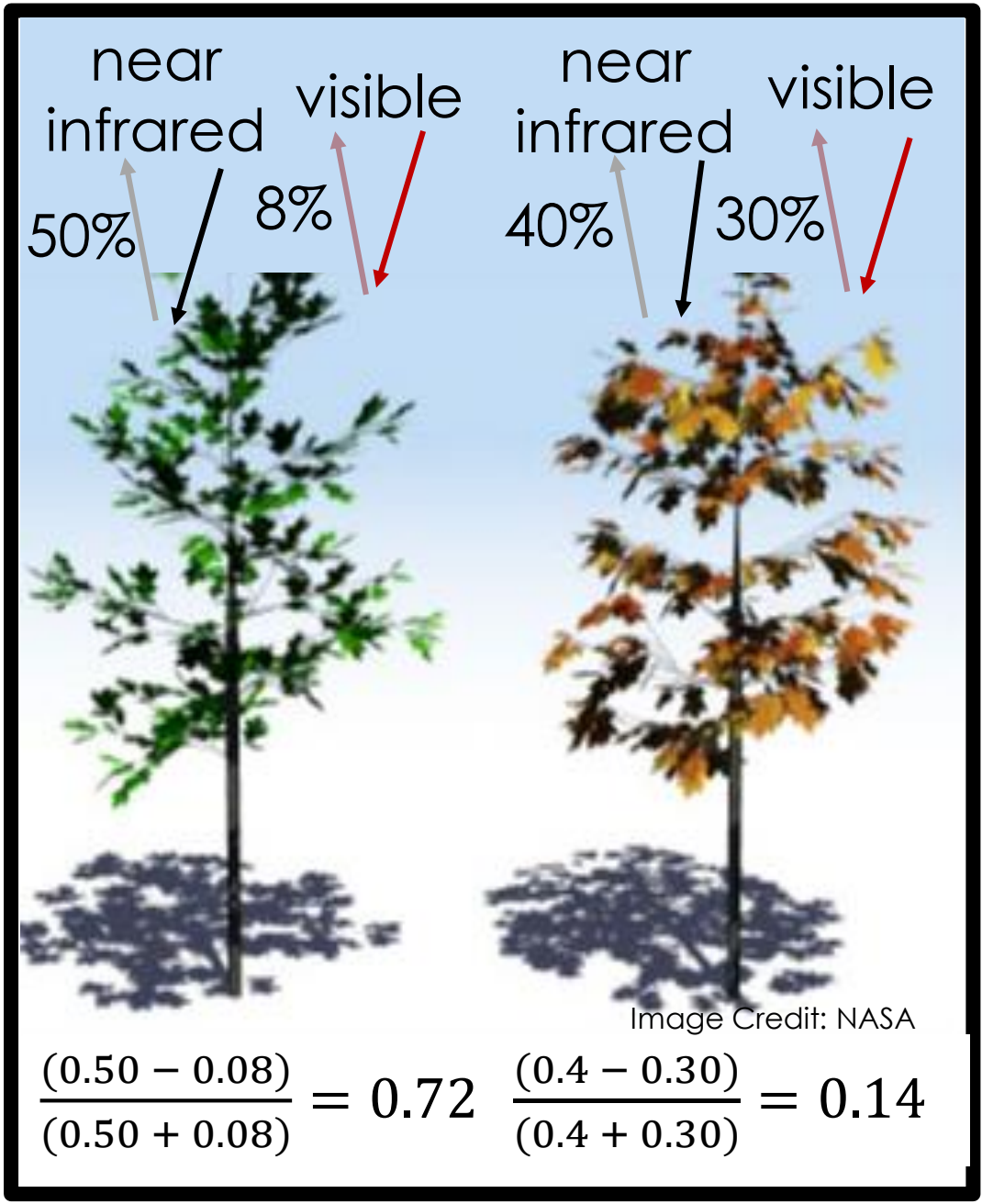
Landsat 8 OLI

NDVI

Normalized
Difference
Vegetation
Index

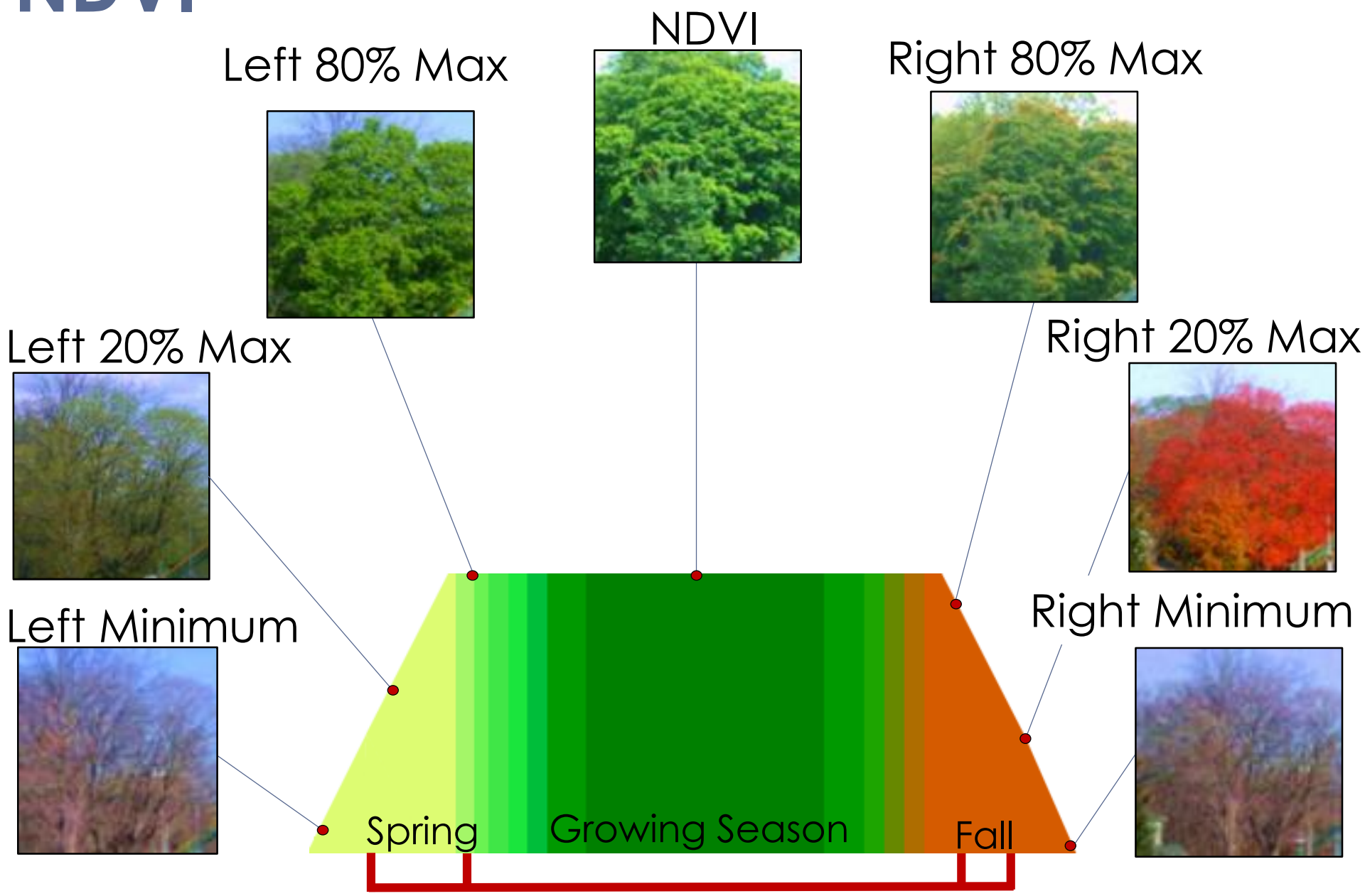
NDVI = (NIR-Red/NIR+Red)

Measure **plant productivity** based on greenness of vegetation



NDVI

Maximum Vegetation Index Value



Images Credit: Steve Norman, USFS ForWarn

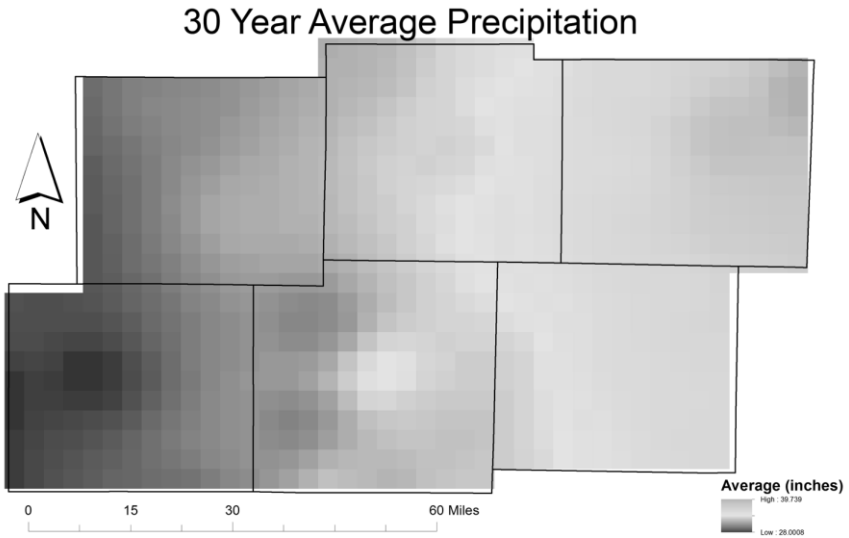
Methodology

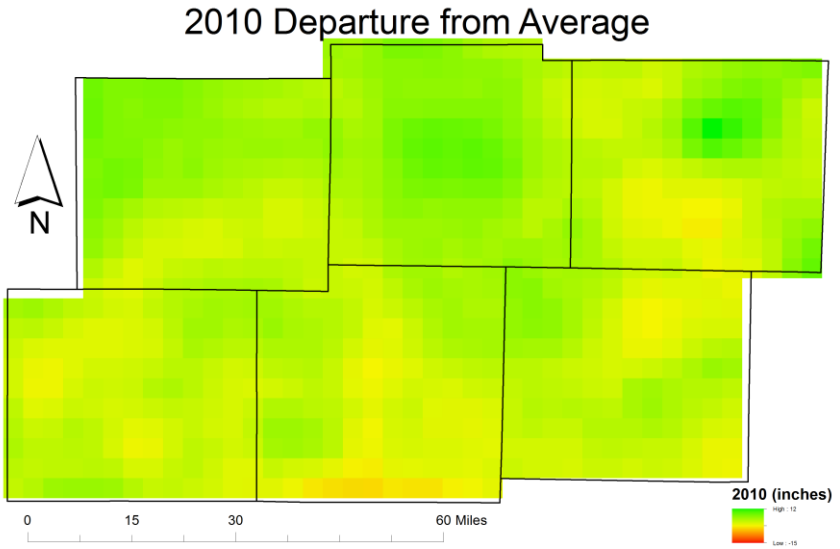
Precipitation — What precipitation conditions create hazardous wildfire conditions?

Phenology — What phenological parameters do different areas have in common?

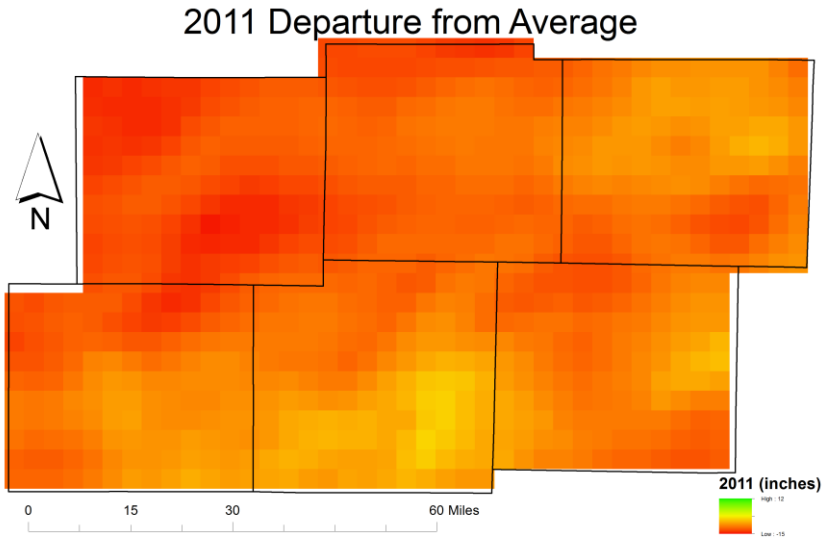
Soils — Do soil types drive the swings in phenology?

Methodology
Climatology



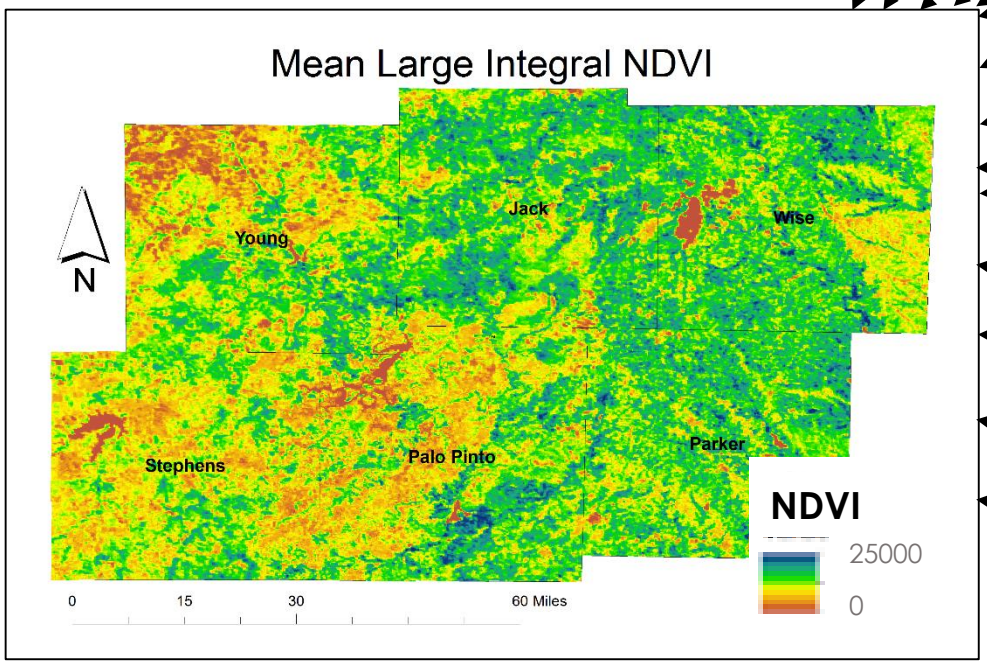


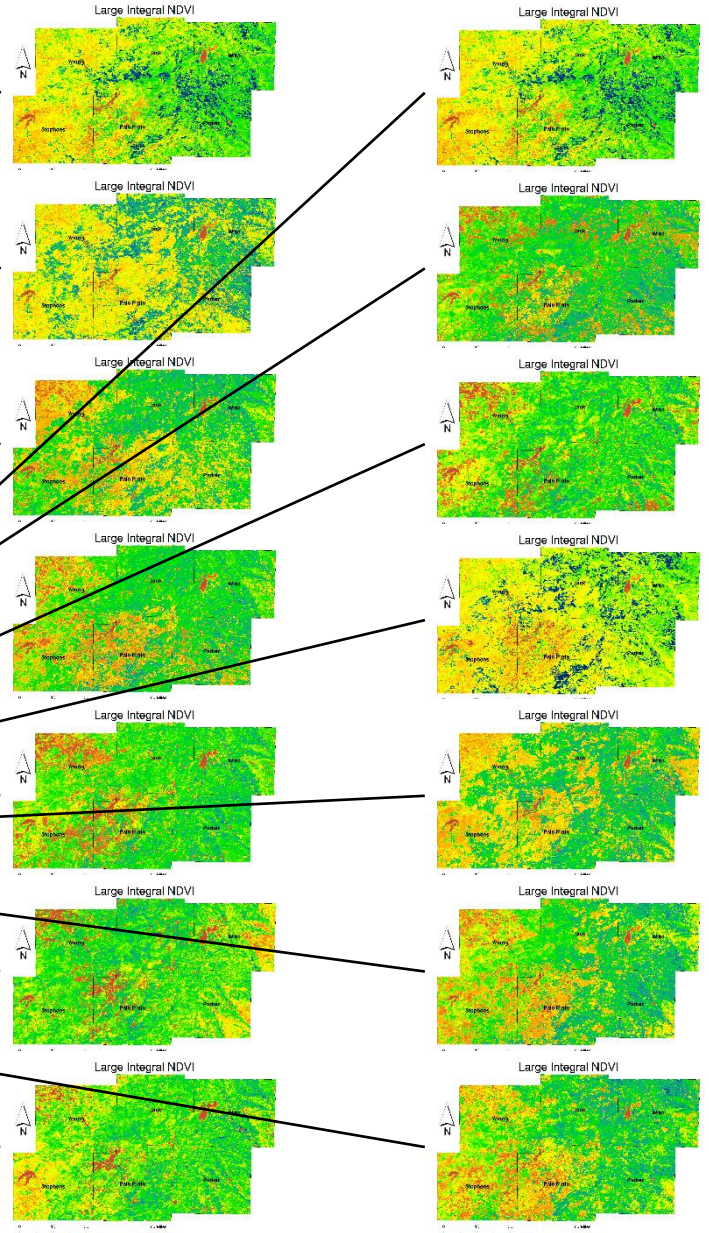
Average Precipitation – 28-40 in/year
2010 – 4 inches **above** normal
2011 – 10 inches **below** normal



Methodology
Phenology

- NDVI and DOY averaged for study period
- Median filter applied to DOY

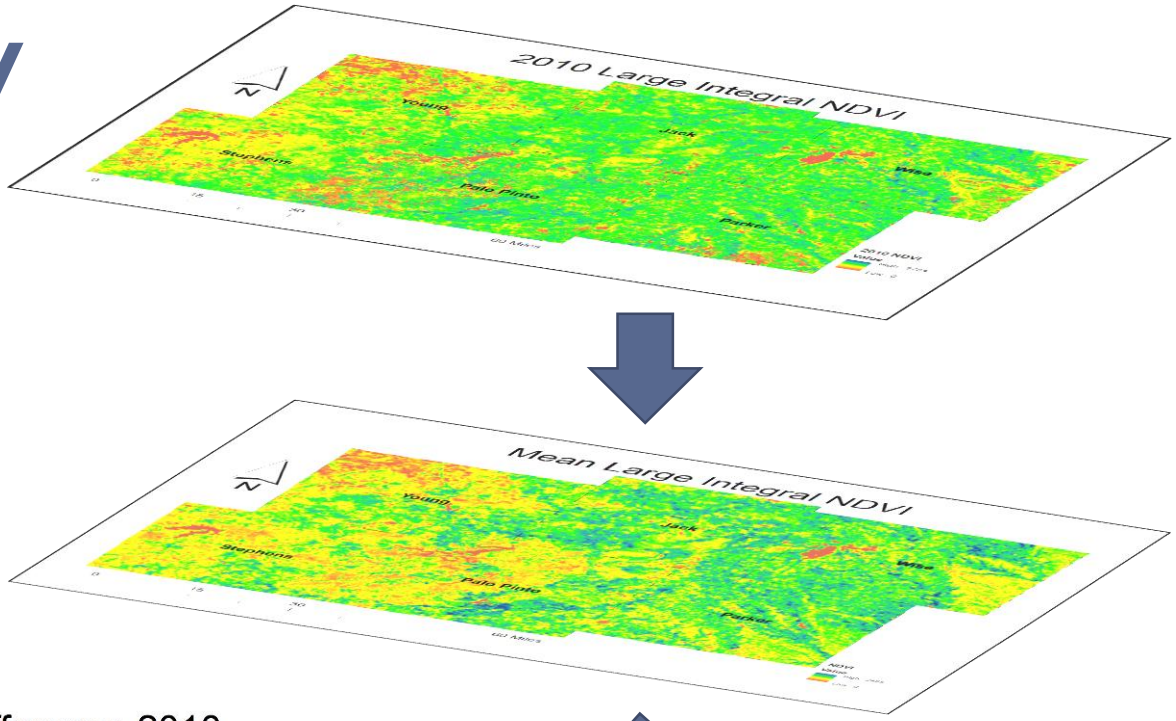


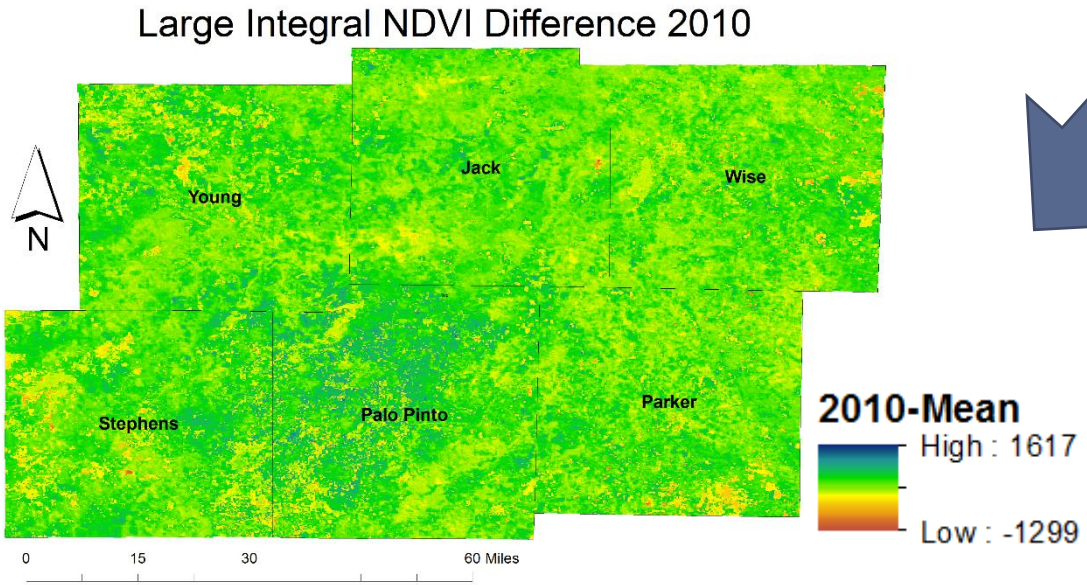


Methodology

Phenology

Parameters from each year were compared to the mean

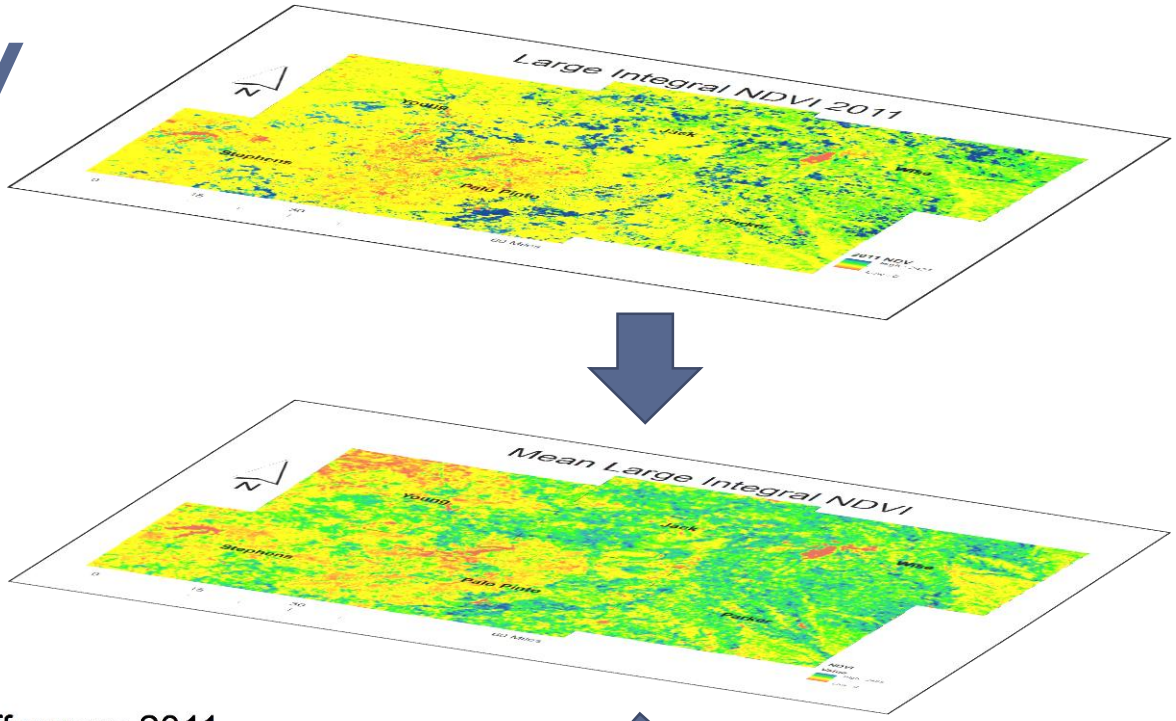


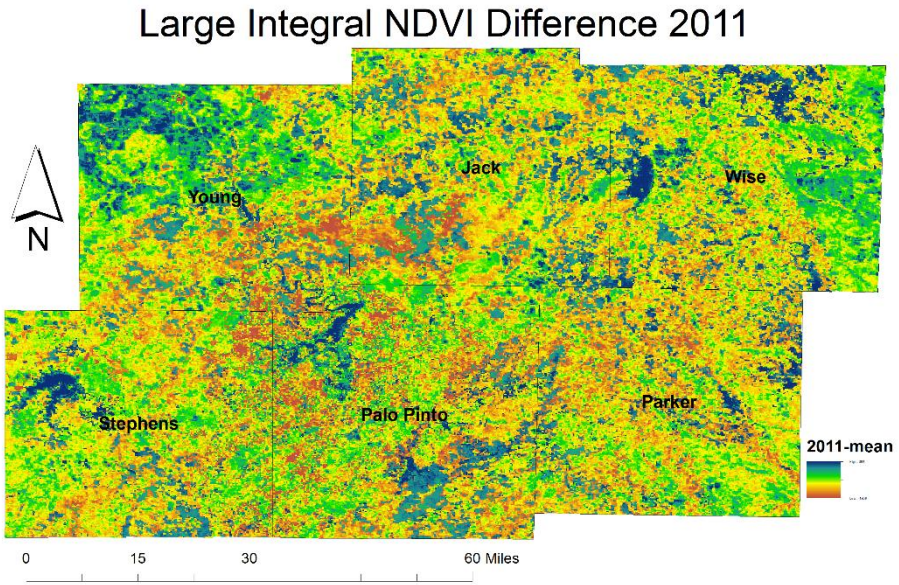


Methodology

Phenology

Parameters from each year were compared to the mean

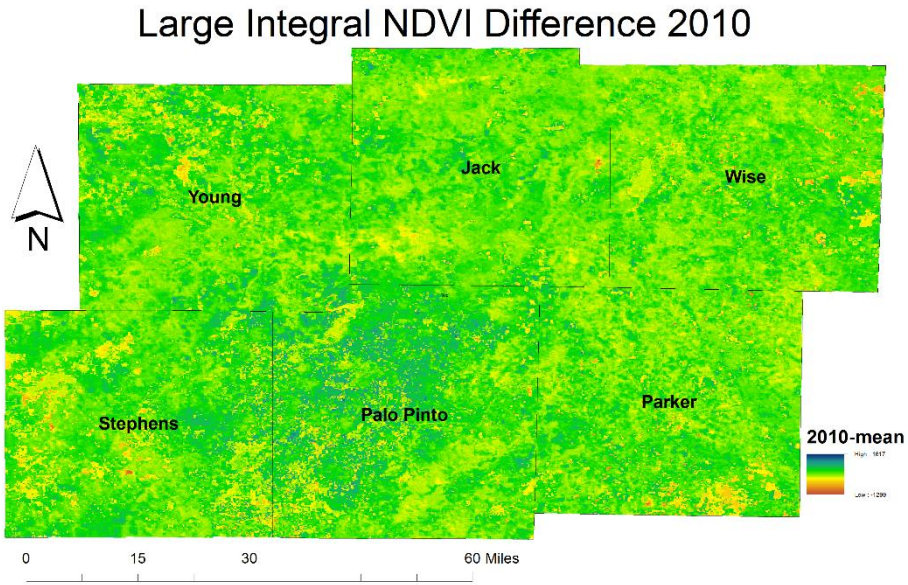


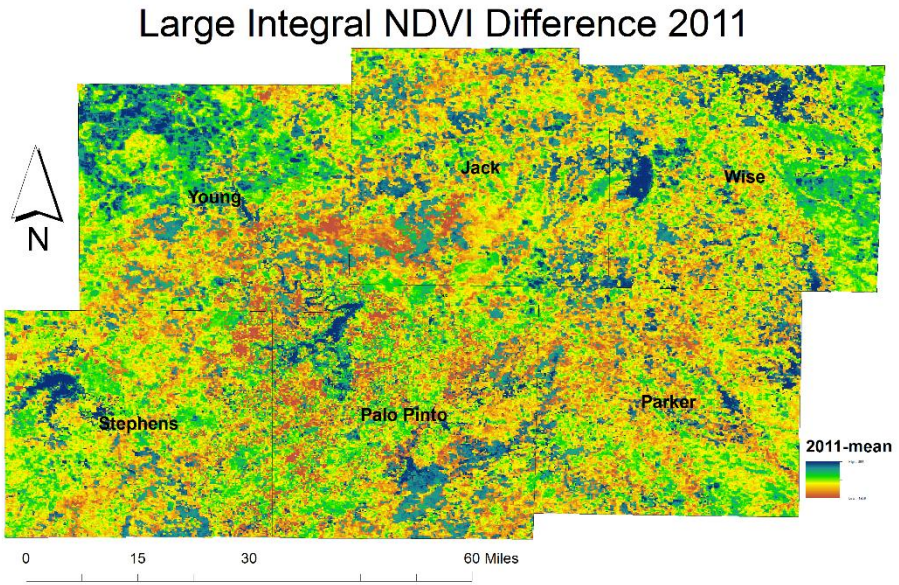


Methodology

Phenology

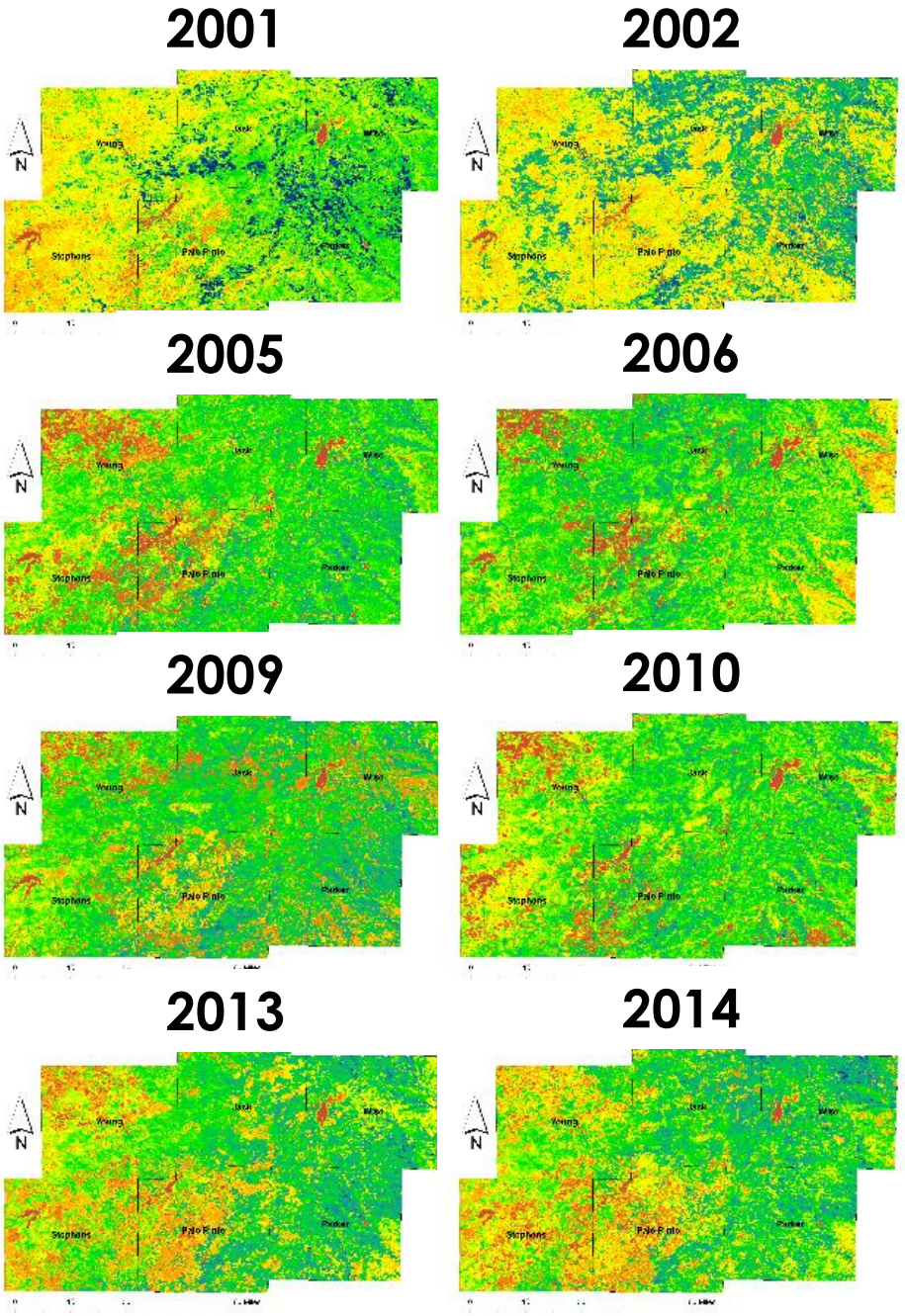
Parameters from each year were compared to subsequent years



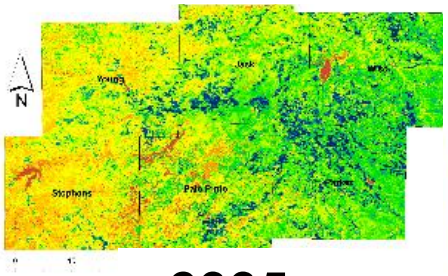


Methodology

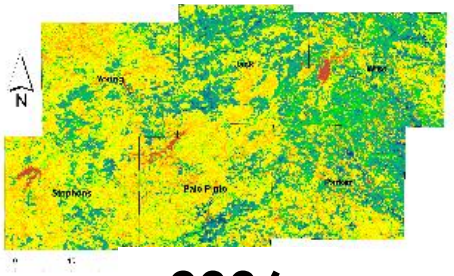
Phenology – Large Integral NDVI



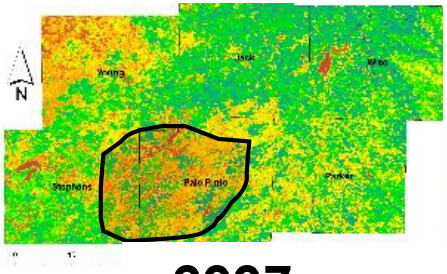
2001



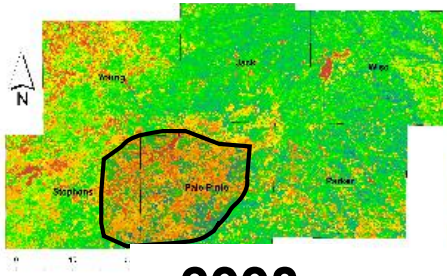
2002



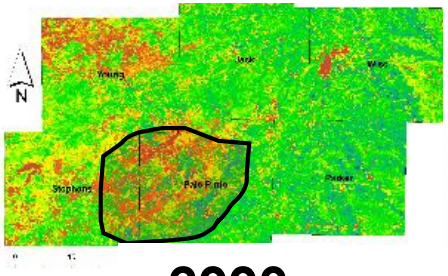
2003



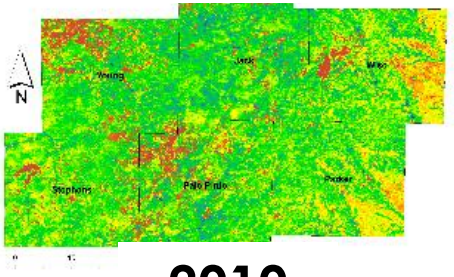
2004



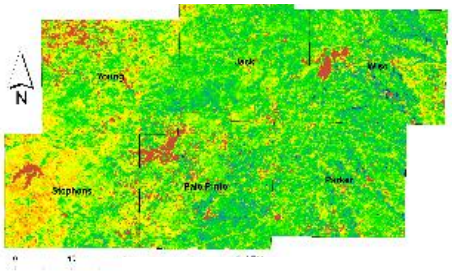
2005



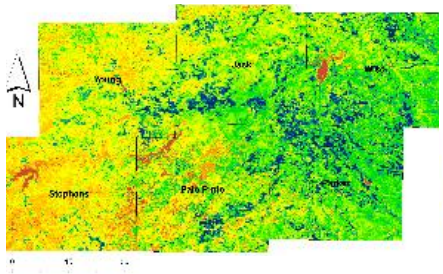
2006



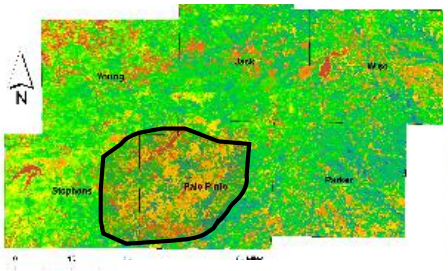
2007



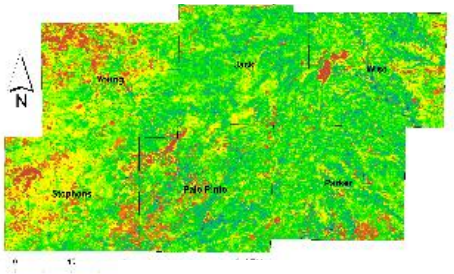
2008



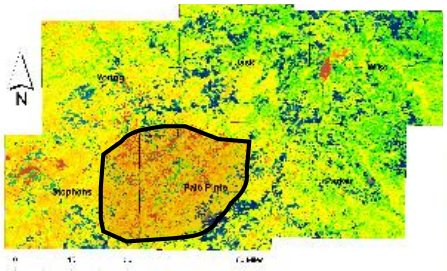
2009



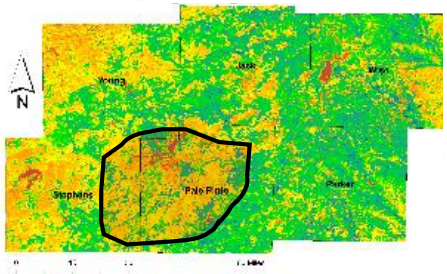
2010



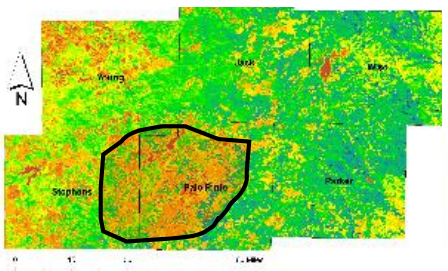
2011



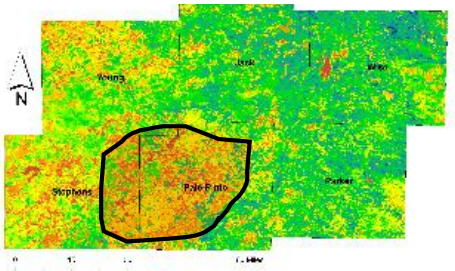
2012



2013

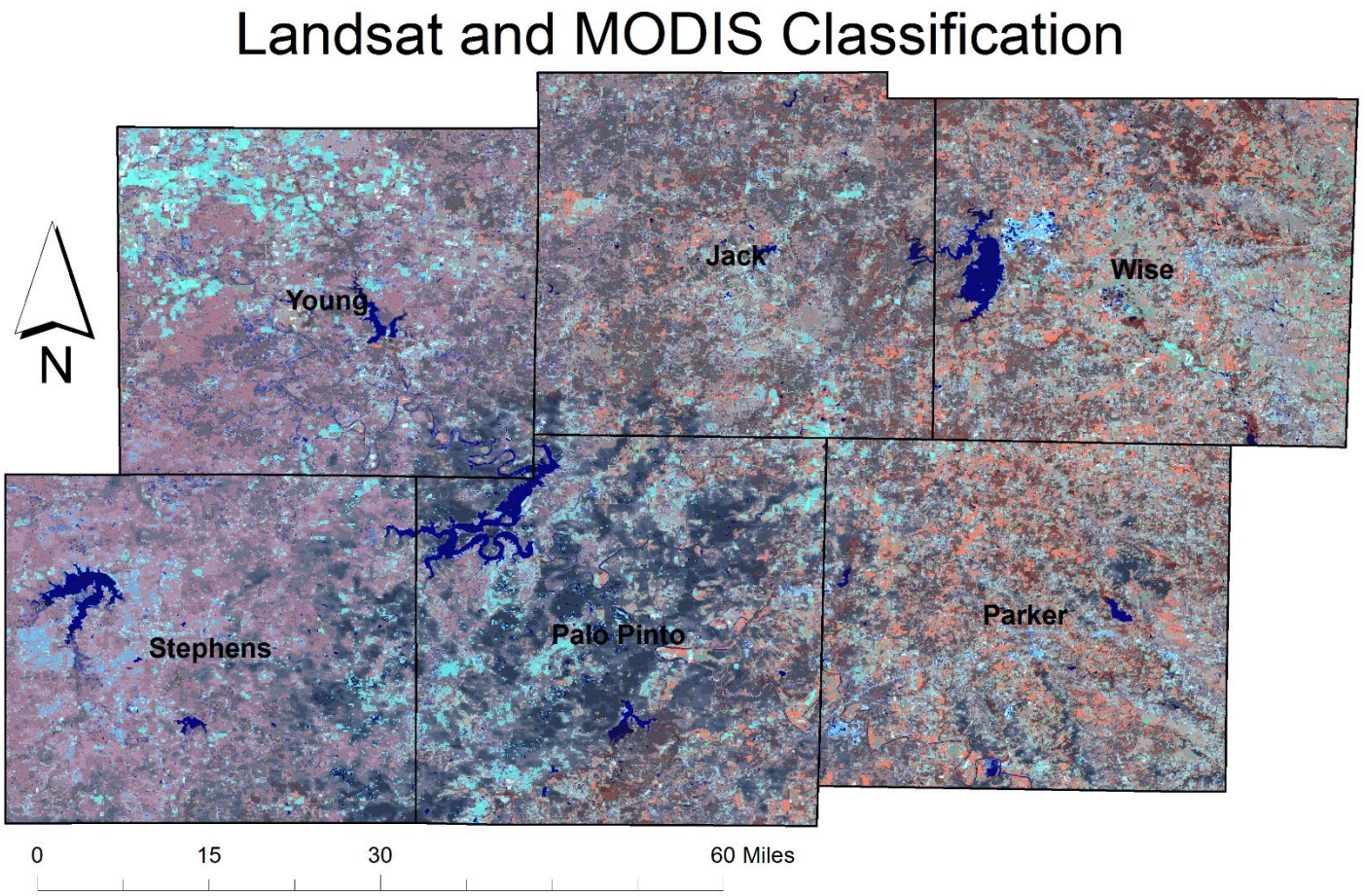


2014



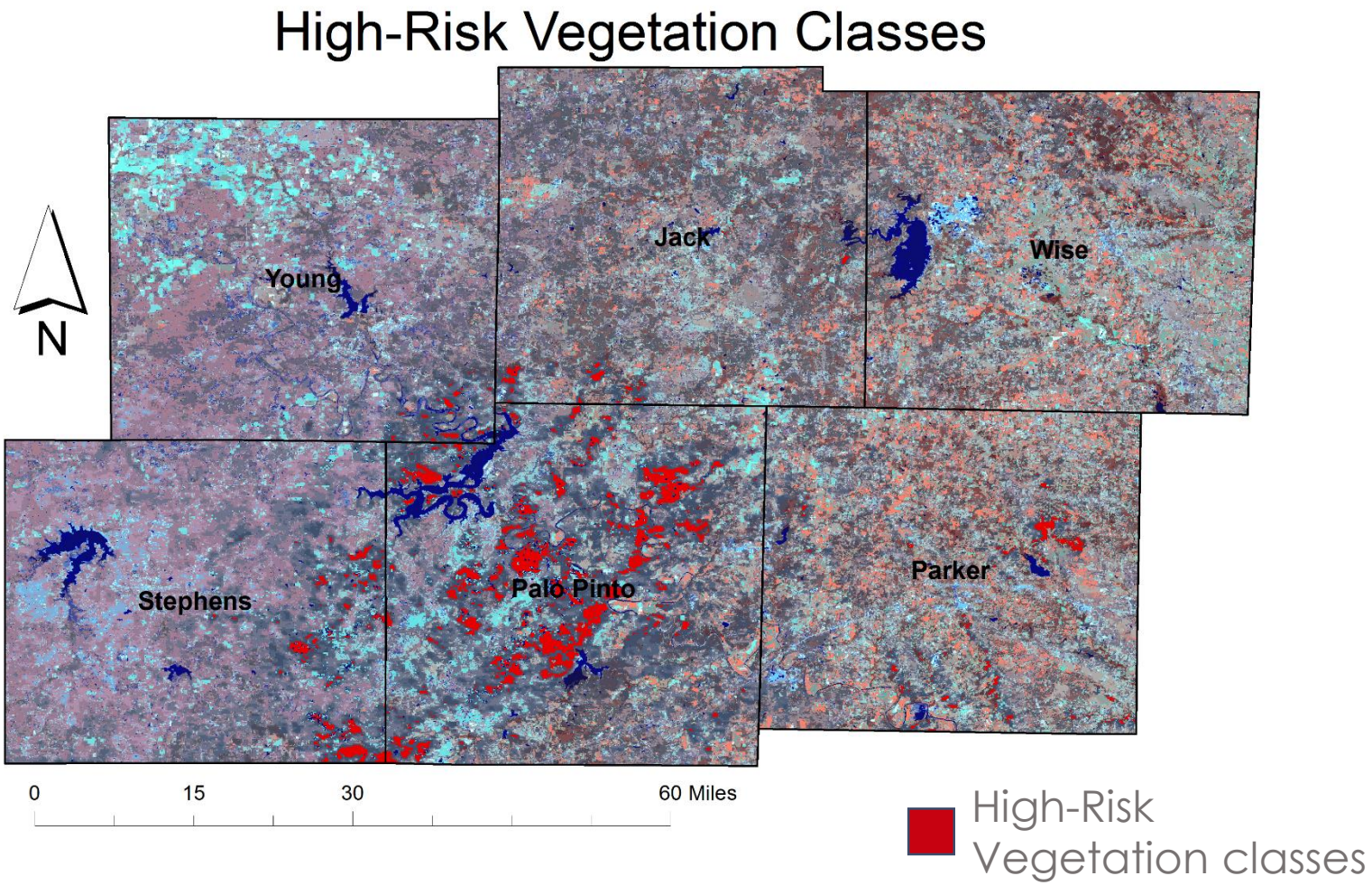
Methodology

Landsat and MODIS land cover classification



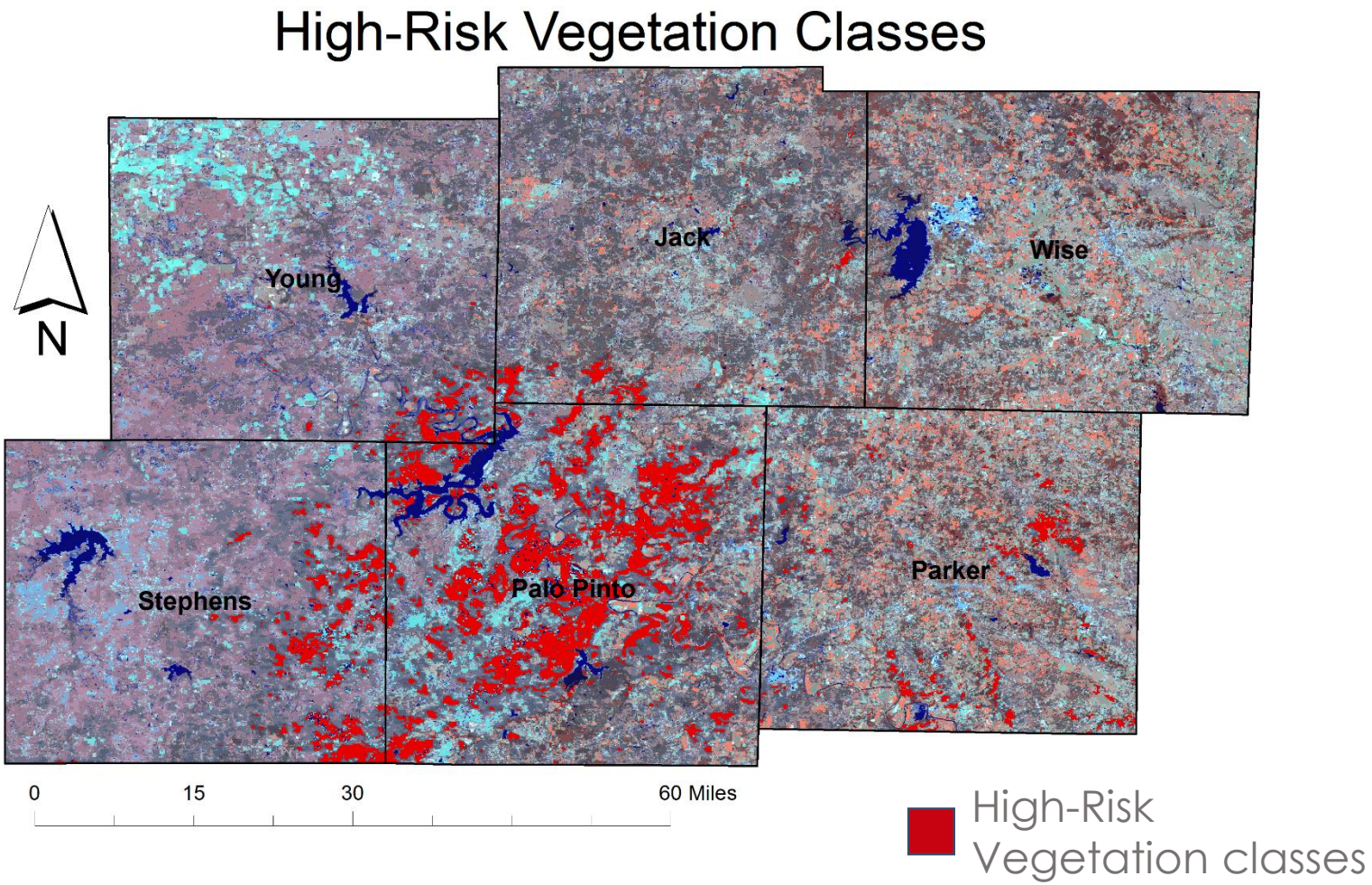
Methodology

Classification



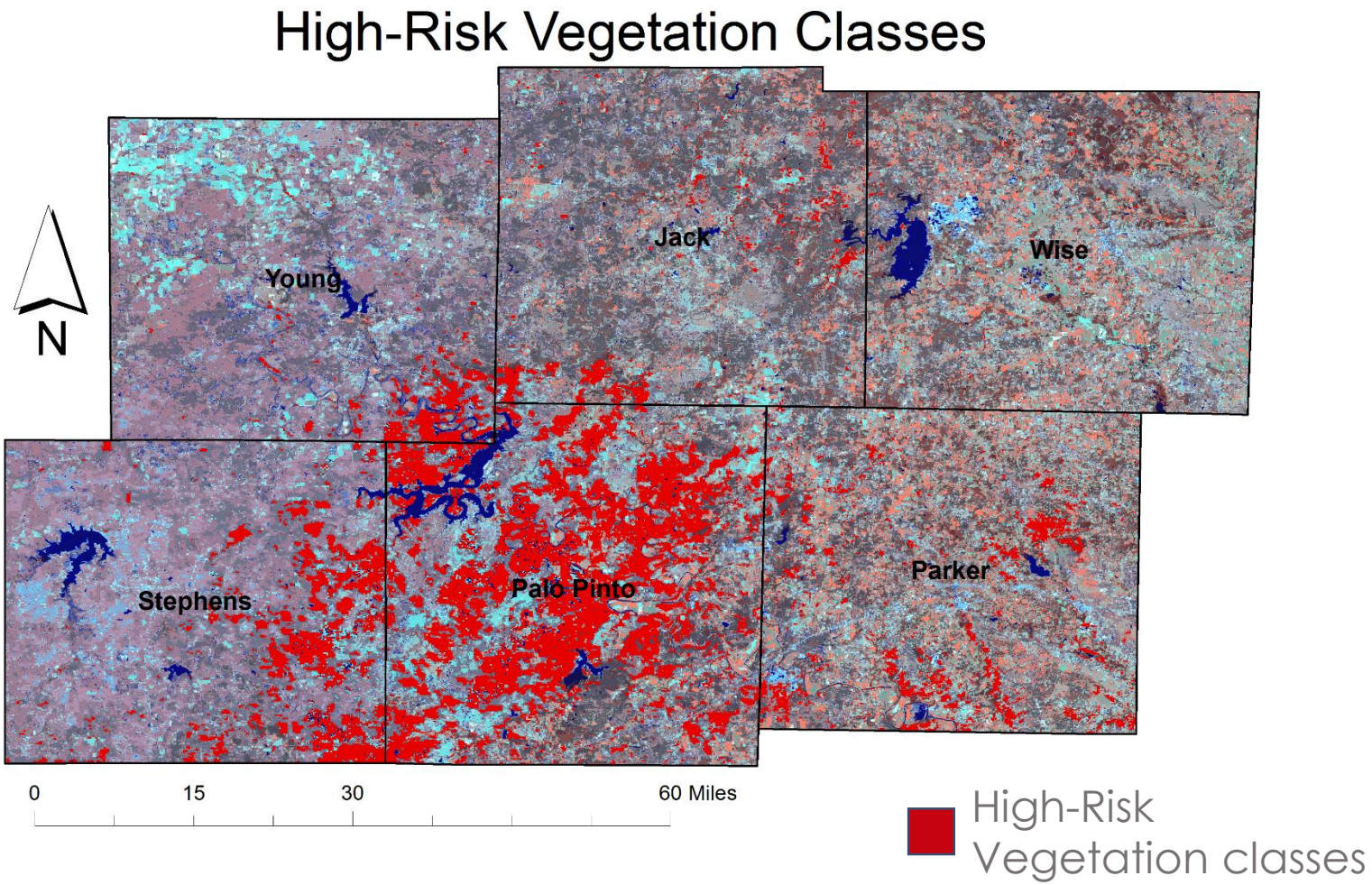
Methodology

Classification



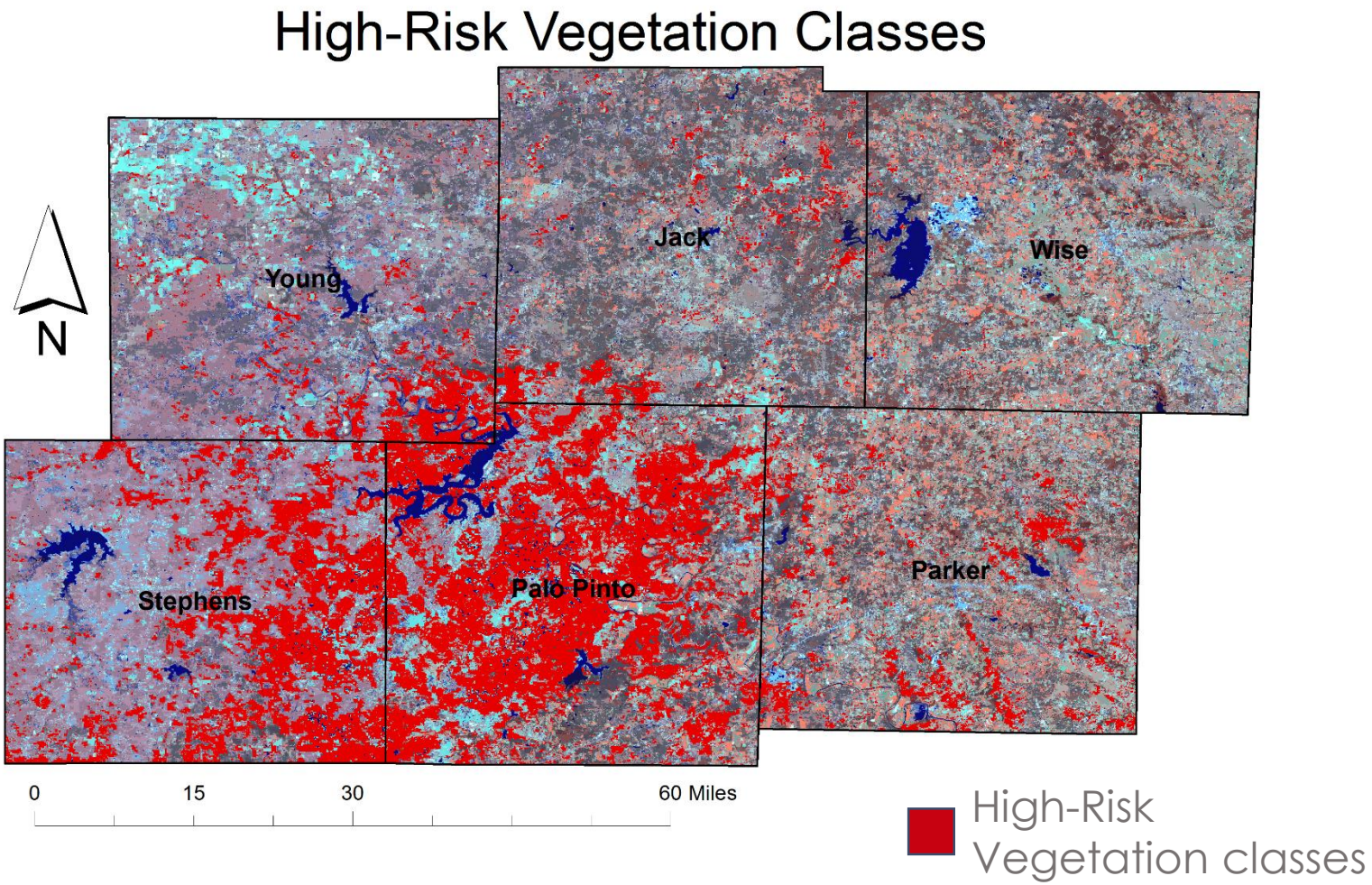
Methodology

Classification



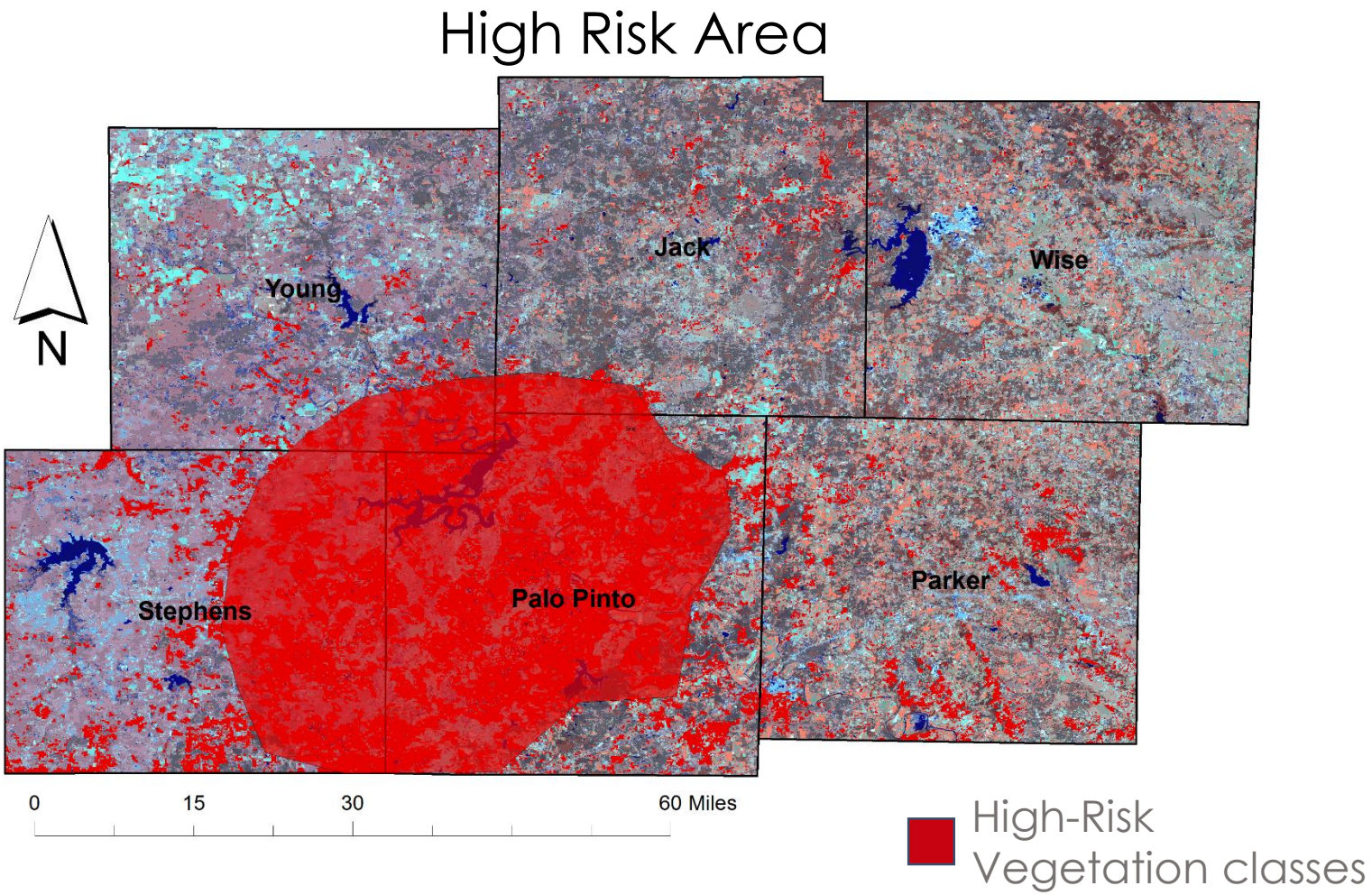
Methodology

Classification



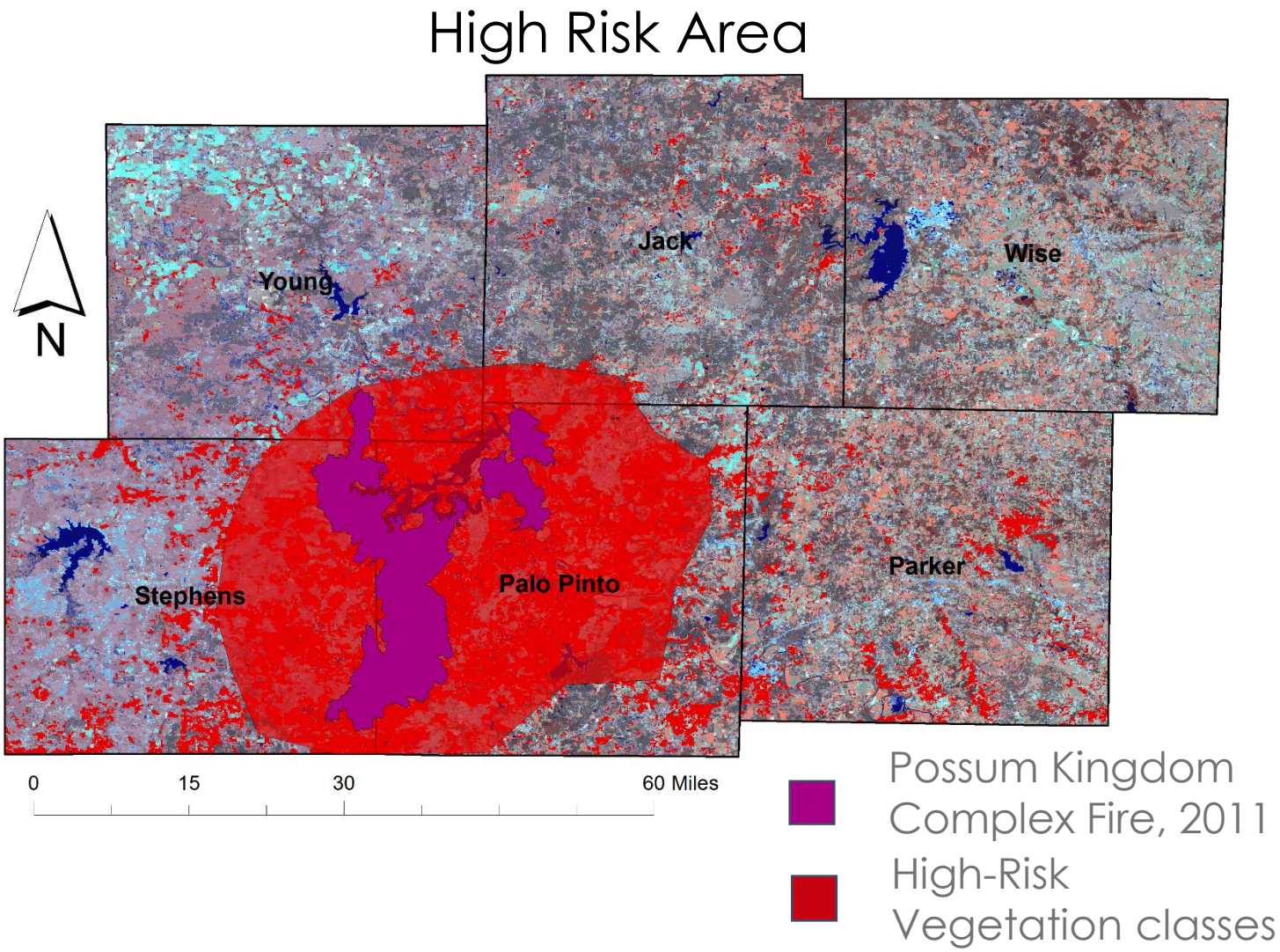
Methodology

Classification

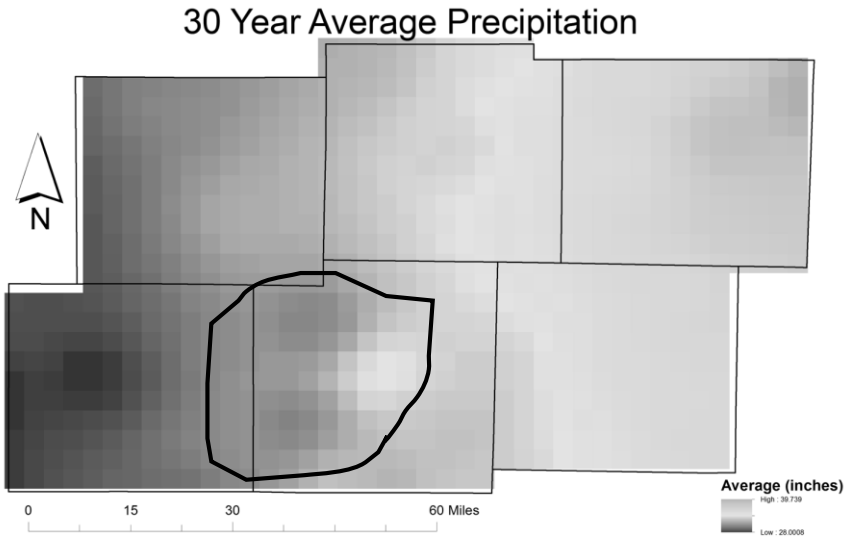


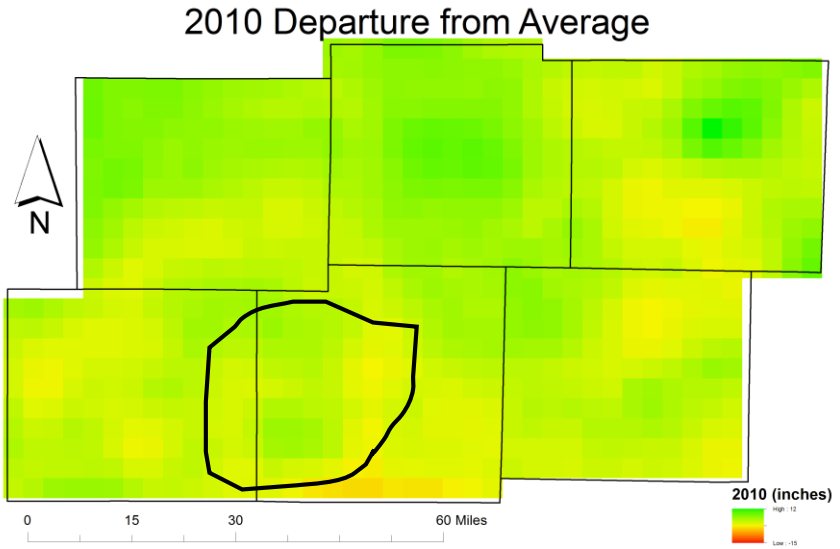
Methodology

Classification

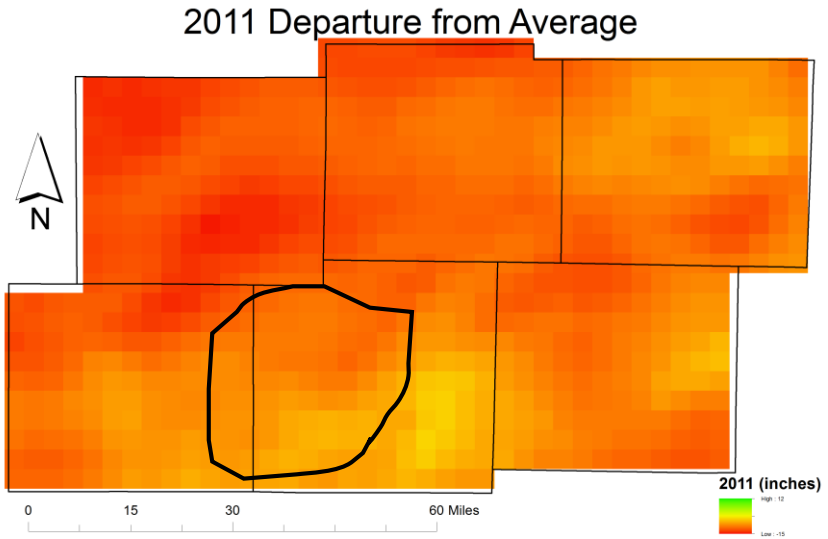


Methodology
Climatology



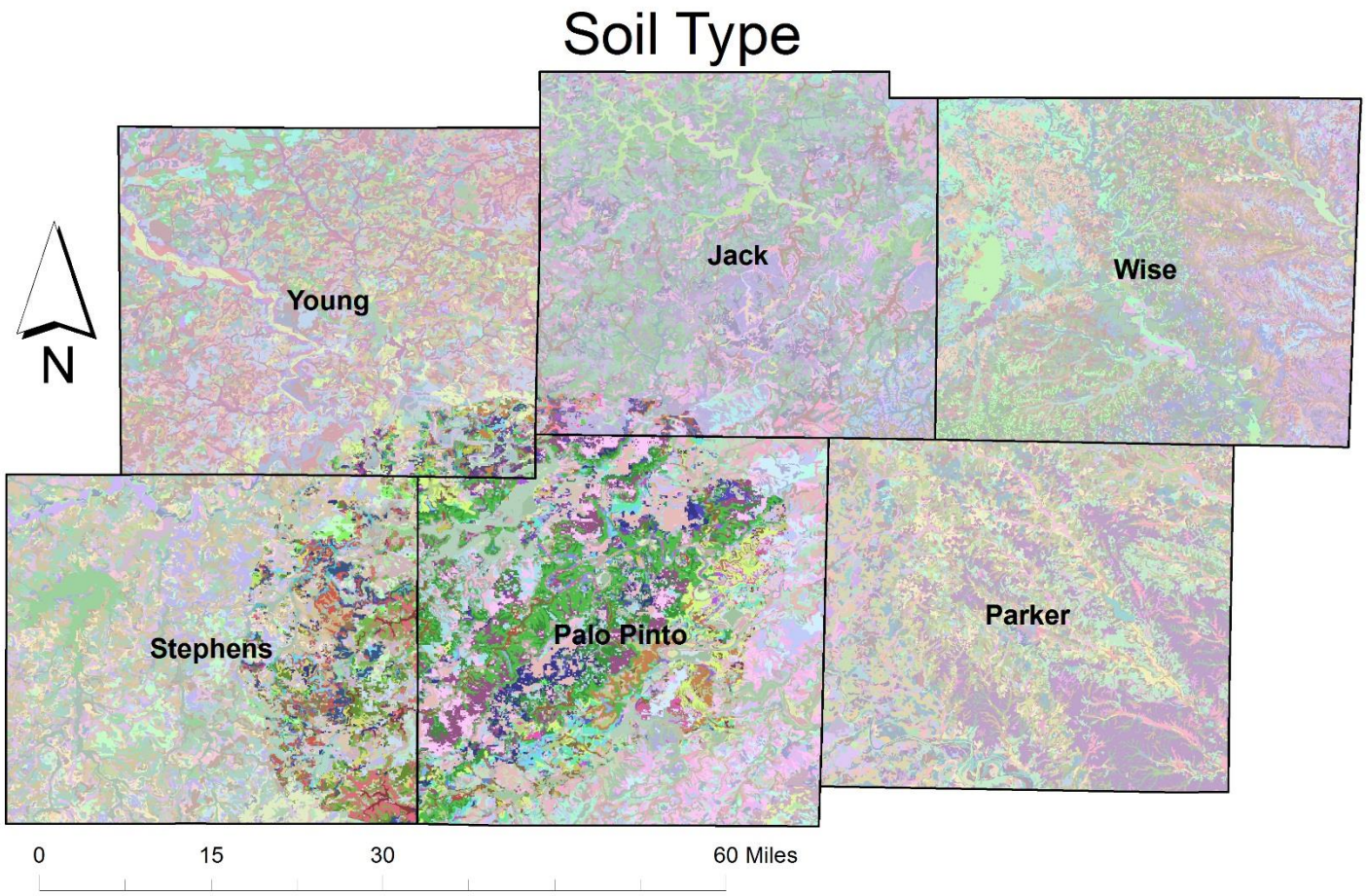


Average Precipitation – 28-40 in/year
2010 – 4 inches above normal
2011 – 10 inches below normal

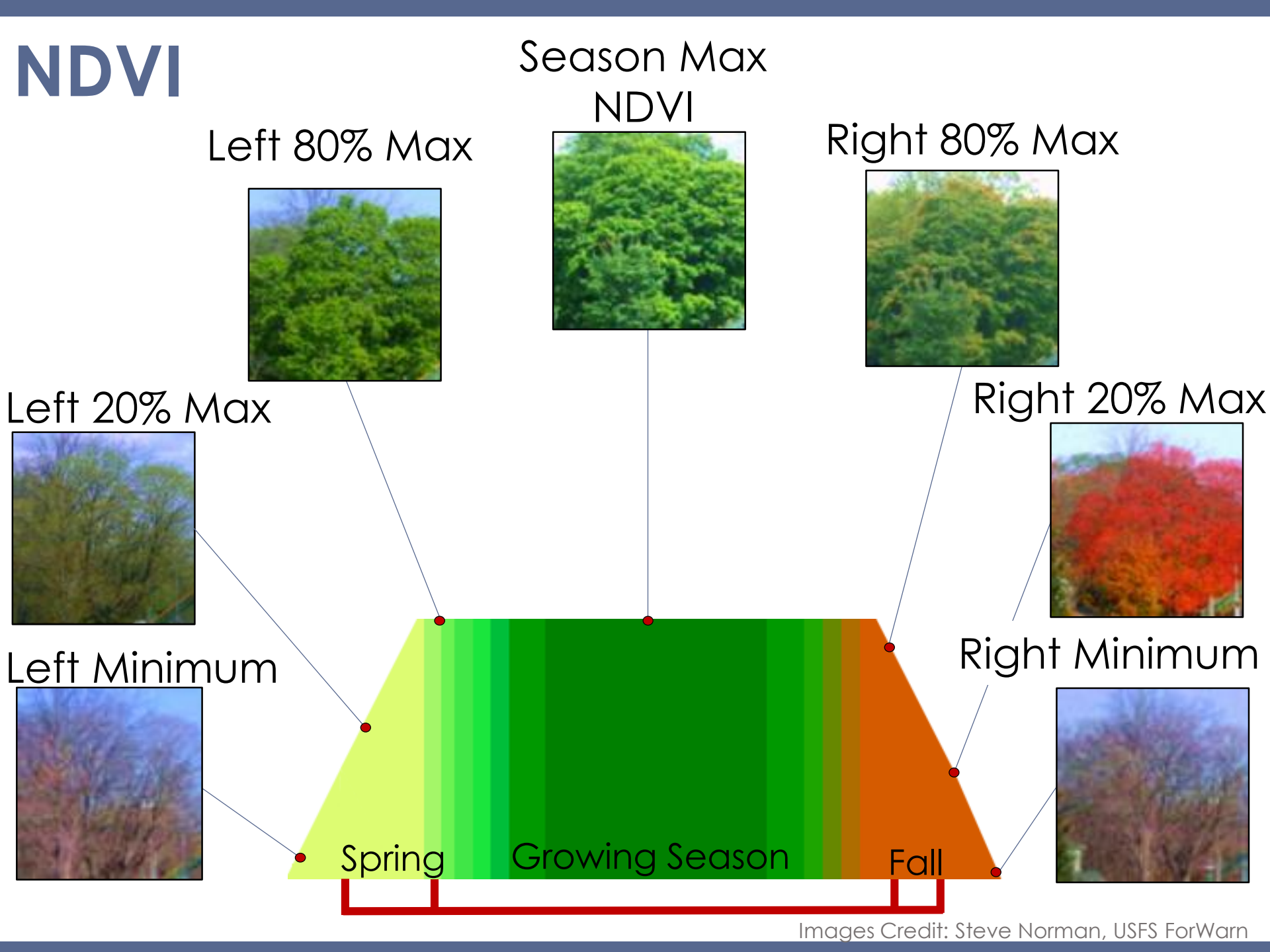


Methodology

Soils



NDVI



Images Credit: Steve Norman, USFS ForWarn

NDVI

Season Max NDVI

Left 80% Max

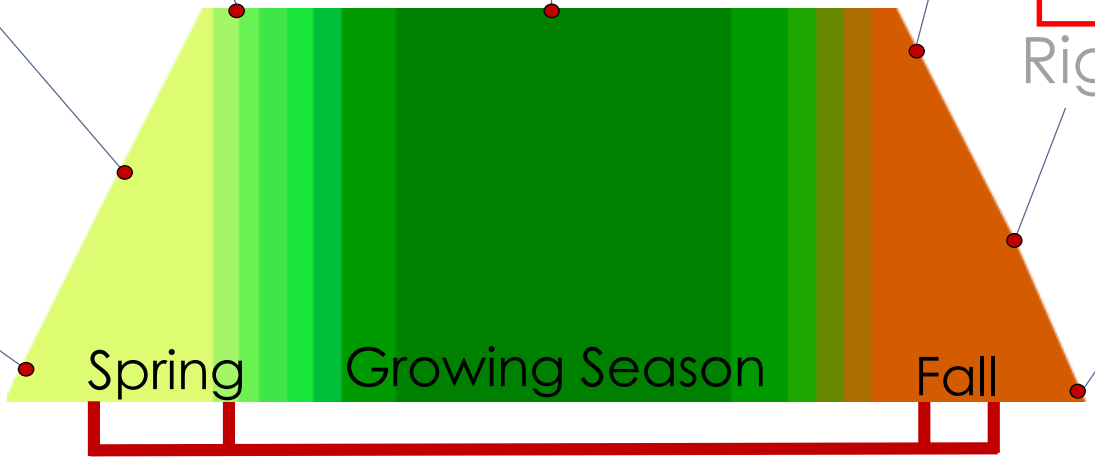
Right 80% Max

Left 20% Max

Right 20% Max

Left Minimum

Right Minimum

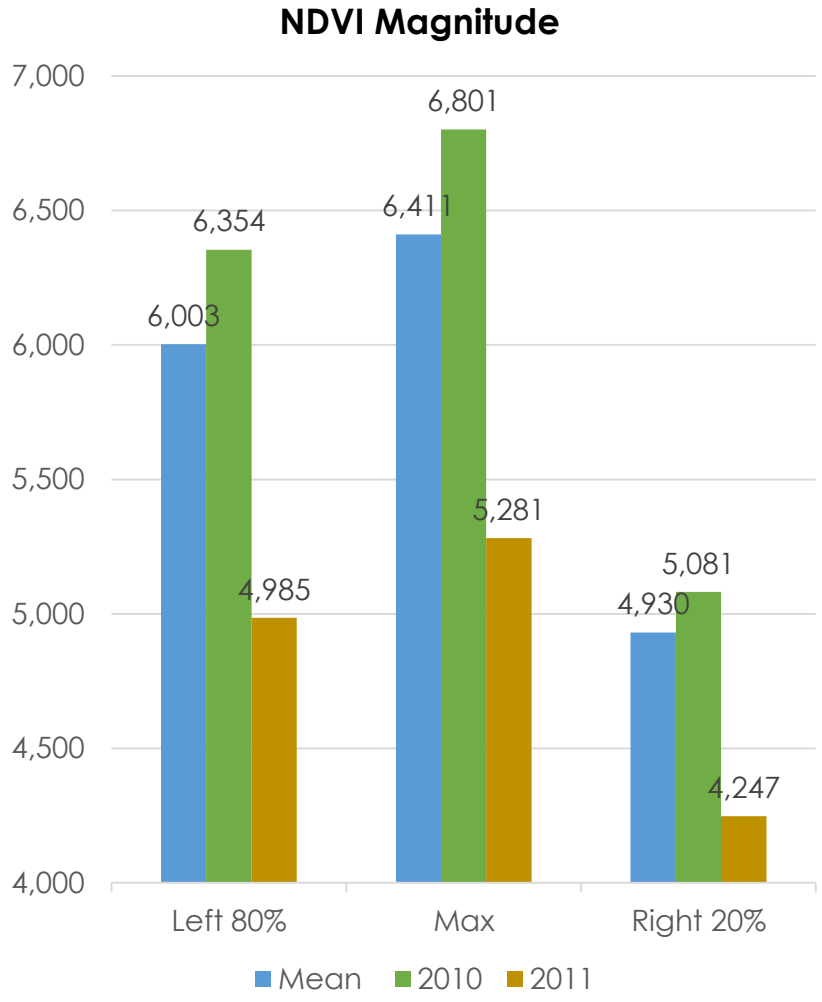


Images Credit: Steve Norman, USFS ForWarn

Results

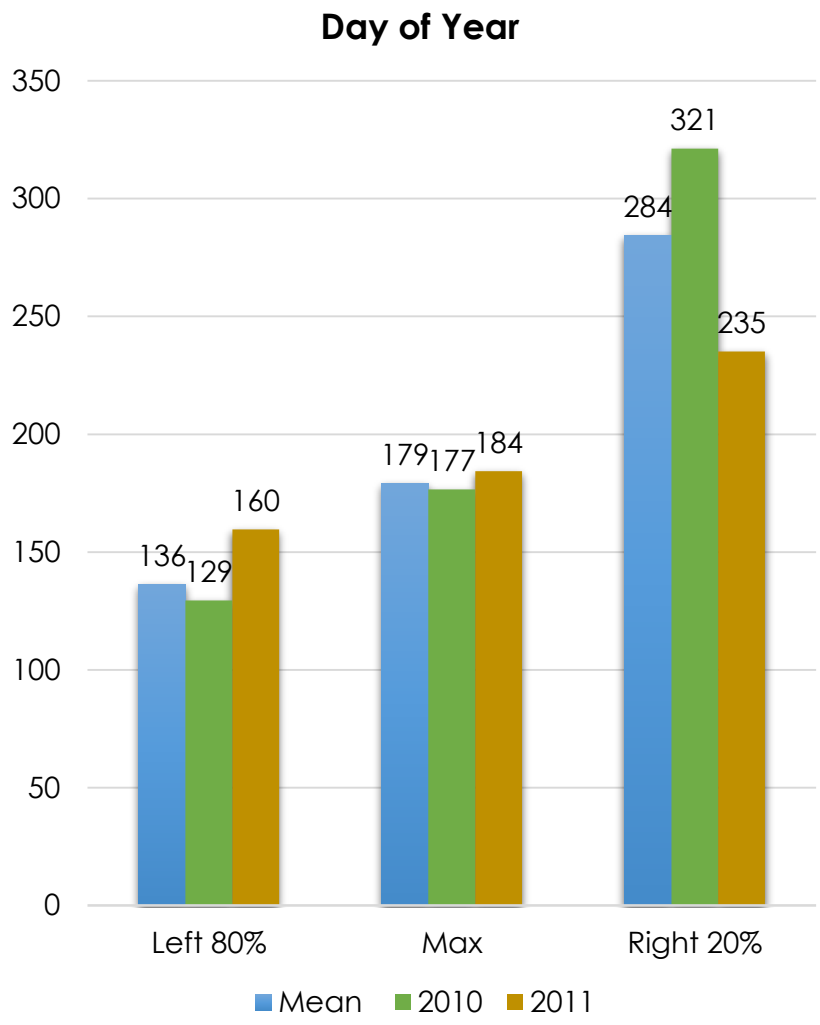
Selected phenology parameters for high-risk area

- NDVI values scaled by 10,000
- **2010** considerably more productive than mean
- **2011** considerably less productive than mean



Results

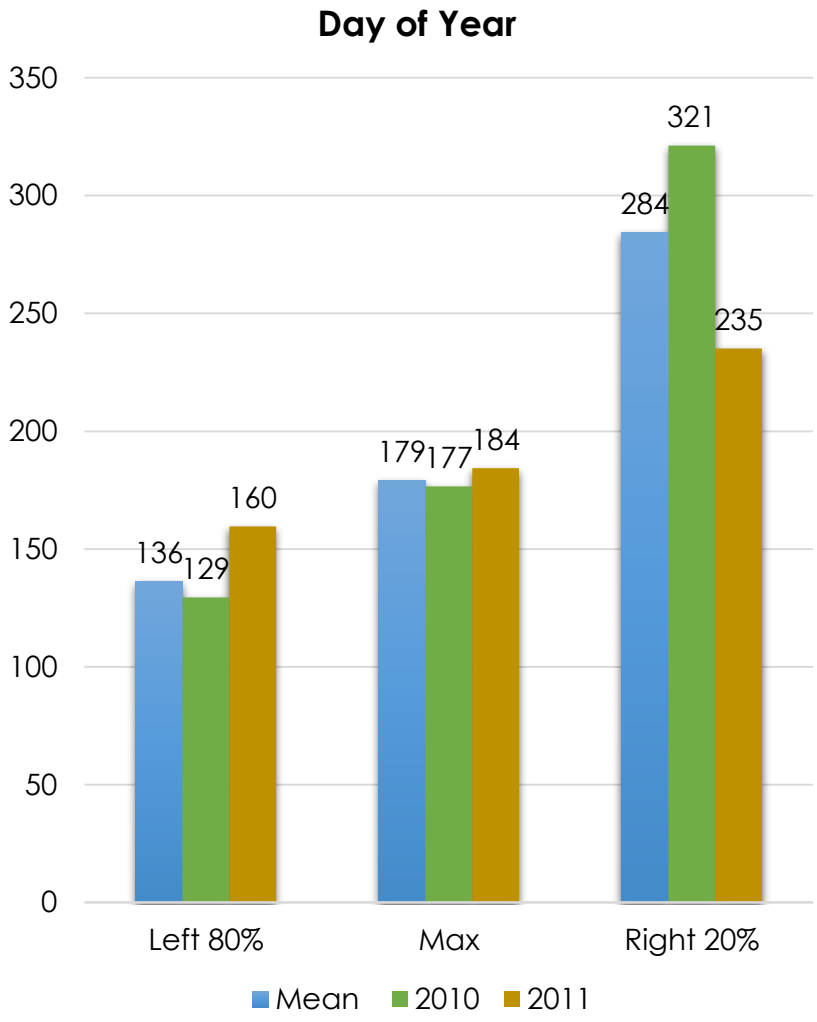
Selected phenology parameters for high-risk area

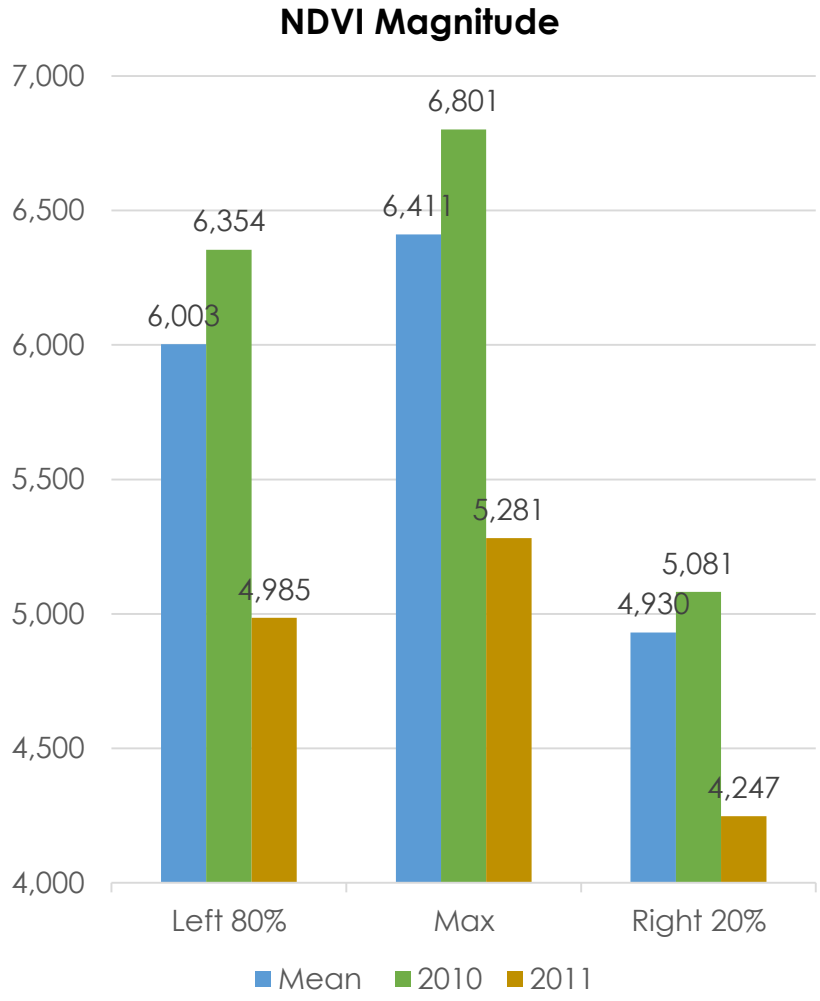


- Day of year values
- **2010** had a much longer growing season than mean
- **2011** had a much shorter growing season than mean

Results

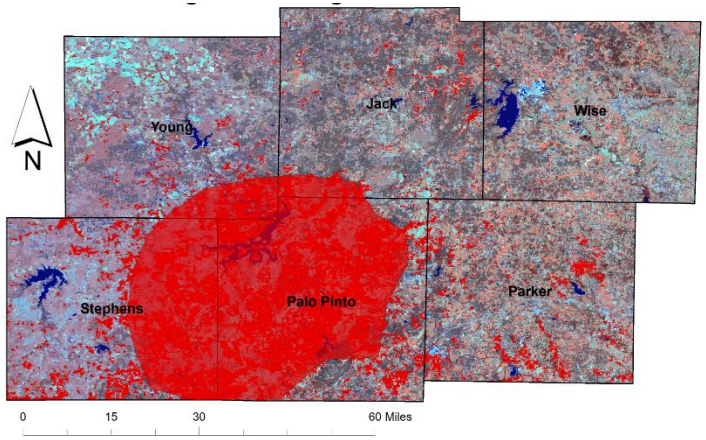
Selected phenology parameters for high-risk area





Results

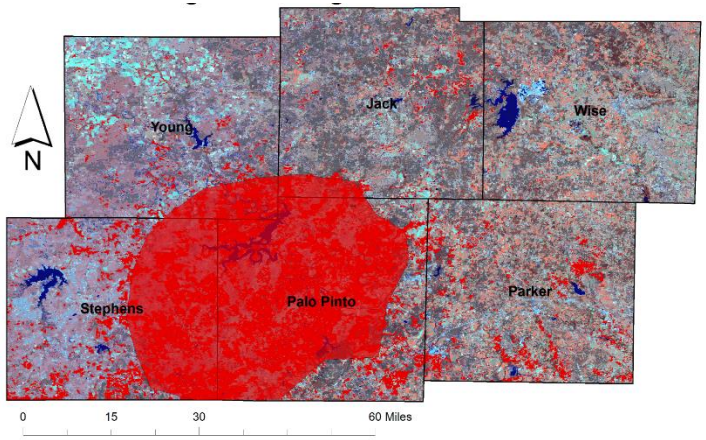
High Risk Area



- If by mid-May the NDVI value has not reached close to 0.6 within the majority of the High-Risk Area, there is a greater risk of wildfires.
- If the previous year had a growing season near 200 days long combined with a max NDVI of 0.7, the fuel load may contribute to more severe wildfires.

Conclusion

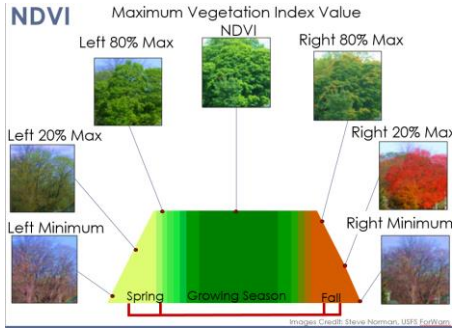
High Risk Area

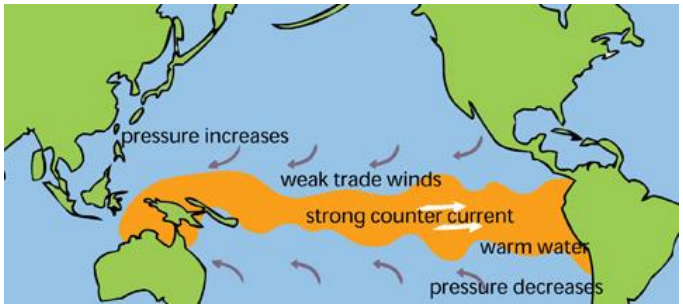


- There is a high-risk area within the study area that has an enhanced phenological response to both wet and dry years relative to the surrounding area.
- This high risk may be driven more by soil type than climate (though the latter does contribute to risk).
- This area should experience greater risk for large, damaging wildfires given a La Nina climatic event after a previously lush year (e.g., 2011 versus 2010).
- As yearly climate swings grow more pronounced and growth continues in the area, this risk may escalate.

Limitations and Future Work

- Look at all points in the growing season "NDVI" curve
- Consider temperature on a monthly basis
- Timing of first freeze
- Look at current El Nino to assess wildfire risk and impacts of this climatic event
- Assess alternative MODIS/Landsat data fusion methods (e.g., STAR FM)





Acknowledgements

Advisors

Joseph Spruce, NASA Stennis Space Center

Dr. Kenton Ross, NASA Langley Research Center

Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration.

This material is based upon work supported by NASA through contract NNL11AA00B and cooperative agreement NNX14AB60A.

Acknowledgements

Partners

Tom Spencer, Texas Forest Service

Curt Stripling, Texas Forest Service

Williams "Bill" Hargrove, USDA Forest Service

Others

Benjamin Beasley, NASA DEVELOP at Stennis Space Center

Alex Holland, NASA DEVELOP at Stennis Space Center

Kristen Kelehan, NASA DEVELOP at Stennis Space Center

This material is based upon work supported by NASA through contract NNL11AA00B and cooperative agreement NNX14AB60A.

References

- "US Forest Service." *US Forest Service*. Web. Oct. 2015.
- "Texas A&M Forest Service Home Page." *Texas A&M Forest Service Home Page*. Web. Nov. 2015.
- National Wildfire Coordinating Group. "National Fire Danger Rating System (NFDRS)." *Van Nostrand's Scientific Encyclopedia* 2005. Web. 11 Oct. 2015.
- Hargrove, William, Joe Spruce, Gerry Gasser, Forrest Hoffman, and Danny Lee. "A New National MODIS-Derived Phenology Data Set Every 16 Days, 2002 through 2006." *USDA Forest Service - Eastern Forest Threat Assessment Center, *NASA Stennis Space Center, and Oak Ridge National Laboratory*.
- All images courtesy of NASA unless stated otherwise.

Questions?


National Aeronautics and Space Administration
DEVELOP
Stennis Space Center